SEDAR 12

Stock Assessment Report 1

Gulf of Mexico Red Grouper

SECTION IV. Review Workshop

SEDAR
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Charleston, SC 29414

SEDAR 12 Review Workshop

Review Panel Consensus Summary

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1. Introduction

1.1. Workshop Time and Place

The SEDAR 12 Review Workshop was held January 29 - February 2, 2007, in Atlanta, Georgia.

1.2. Terms of Reference

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment*.
2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock*.
3. Recommend appropriate estimates of stock abundance, biomass, and exploitation*.
4. Evaluate the methods used to estimate population benchmarks and management parameters (*e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies*); provide estimated values for management benchmarks, a range of ABC, and declarations of stock status*.
5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition* (e.g., exploitation, abundance, biomass).
6. Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide measures of uncertainty for estimated parameters*. Ensure that the implications of uncertainty in technical conclusions are clearly stated.
7. Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations**.
8. Evaluate the SEDAR Process. Identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops; identify any additional information or assistance which will improve Review Workshops; suggest improvements or identify aspects requiring clarification.
9. Review the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment.
10. Prepare a Peer Review Consensus Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Prepare an Advisory Report summarizing key assessment results. (Reports to be drafted by the Panel during the review workshop with a final report due two weeks after the workshop ends.)

* The review panel may request additional sensitivity analyses, evaluation of alternative assumptions, and correction of errors identified in the assessments provided by the assessment workshop panel; the review panel may not request a new assessment. Additional details regarding the latitude given the review panel to deviate from assessments provided by the assessment workshop panel are provided in the *SEDAR Guidelines* and the *SEDAR Review Panel Overview and Instructions*.

** The panel shall ensure that corrected estimates are provided by addenda to the assessment report in the event corrections are made in the assessment, alternative model configurations are recommended, or additional analyses are prepared as a result of review panel findings regarding the TORs above.

1.3. Workshop Participants

Review Panel

Richard Methot ..... Chair/NOAA Fisheries NWFSC
John Casey ..... CIE/CEFAS
Stewart Frusher ..... CIE/University of Tasmania
Paul Medley ..... CIE

Council Appointed Observers

Martin Fisher ..... GMFMC AP
Bob Muller ..... GMFMC FSAP/FL FWC
Dennis O'Hearn ..... GMFMC AP

Analytical Team

Craig Brown ..... NOAA Fisheries SEFSC
Shannon Cass-Calay ..... NOAA Fisheries SEFSC
Steve Turner ..... NOAA Fisheries SEFSC
John Walter ..... NOAA Fisheries SEFSC

Council Representative

William Teehan ..... GMFMC/ FL FWC

SERO Representative

Andy Strelcheck ..... NOAA Fisheries SERO

Observers

Mark Robson ..... SAFMC/ FL FWC
Jim Weinberg ..... NOAA Fisheries NEFSC

Staff

John Carmichael ..... SEDAR Coordinator
Tyree Davis ..... IT Support/SEFSC
Stu Kennedy ..... GMFMC
Tina Trezza ..... GMFMC

1.4. Review Workshop Working Papers & Documents

Working Papers:

SEDAR12-RW01	Gulf Council RFSAP report excerpts regarding red grouper assessments, 1999-2002.	anon.

Reference Documents:

SEDAR12-RD09 SFD 98/99-57 1999	Trends in red grouper mortality rate estimated from tagging data	Legault et al
SEDAR12-RD10 unpub. SEFSC manu. no date	Red grouper mean size at age: An evaluation of sampling strategies using simulated data	Goodyear, C. P.
SEDAR12-RD11 SEFSC Pan. City Lab. Cont. # 2002-07 2002	Characterization of red grouper reproduction from the Eastern Gulf of Mexico.	Collins, L. A. and 5 co-authors.
SEDAR12-RD12 FL FWCC/FWRI	Effects of the 2005 red tide event on recreational fisheries in Southwest Florida	Barbieri, L. and J. Landsberg
SEDAR12-RD13 J. Fish. Bio. 49:627-647. 1996	The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural systems and aquaculture.	Lorenzen, K.
SEDAR12-RD14 2005 Phil. Trans. Royal Soc. London. Fisheries theme issue 2004	Population dynamics and potential of fisheries stock enhancement: practical theory for assessment and policy analysis	Lorenzen, K.

2. Review Panel Consensus

Executive Summary

The SEDAR 12 assessment team did an outstanding job responding to the recommendations from past review panels and updating the assessment. They were highly responsive to requests from the Review Panel (RP). The SEDAR process itself was well organized and well implemented by the SEDAR chair. In addition, the RP thanks the fishery representatives who attended the meeting and made a very positive contribution to the success of the review.

The RP finds that the red grouper assessment in 2006 is a significant improvement over the assessment conducted in 2002. In particular, the addition of longer time series of indices has improved estimates of long term trends, direct age composition data has greatly improved estimates of year-to-year changes in recruitment and has allowed modification of the estimated level of natural mortality. As expected from an assessment update, the assessment is now able to track more recent recruitments, notably the large recruitment from the 1999 year class. However, lack of a pre-recruit survey prevents detection of recruitment fluctuations past 2002. Some revision of historical stock status estimates has occurred, and the RP finds that the magnitude of these changes is not unexpected given the degree of uncertainty in the estimates.

The stock in 2006 is estimated to be at a sustainable level of abundance and the current level of total catch is consistent with keeping the stock near this level of abundance. The stock is estimated to be fully rebuilt and overfishing is not occurring. Management measures and other factors that influence the level of fishing activity, and therefore fishing mortality (F), have resulted in recent levels of F that are quite close to the F level that would produce optimum yield (OY). This F level is set to 75% of the overfishing level (MFMT) in the FMP covering red grouper. This conclusion is derived from model results that are clearly supported by the stable or upward trends in the fishery CPUE and survey indicator data, and in the fishery age composition data which indicate a broad age distribution with an increasing number of older fish appearing in the fishery and continued occurrence of new recruits.

Principal changes in the data inputs and model structure include: using direct observations of age composition in the fishery and survey, rather than blurred age estimates derived from sizes of fish; reducing the level of natural mortality from the constant level of 0.2 to a more reasonable lower value that reflects the maximum age of fish occurring in the fishery; refining the estimate of reproductive output to be used as the basis for tracking the spawning potential of the stock; refining the calculation of discards and discard mortality for the different sectors of the commercial and recreational fishing fleets; inclusion of fishery-independent surveys that can track trends in stock abundance without the confounding effect of drift in catchability that is commonly associated with the CPUE of fishery data.

Major future recommendations include: investigate trends in fishery catchability, refine estimates of natural mortality and other life history factors, continuation of NMFS longline survey, continued work on discard estimates and discard mortality, and migrate the analysis to a more flexible assessment modeling framework.

2.1. Statements addressing each TOR

1) Evaluate the adequacy, appropriateness, and application of data used in the assessment.

Life History

In general the RP was impressed at the amount of data available and the extent of analysis. The addition of ages obtained directly from red grouper otoliths has significantly improved the assessment. The RP had some concern that the reproductive data did not cover the entire spectrum of sizes/ages well because these data are typically collected opportunistically rather than through a specifically designed program to sample for life history characteristics. The fact that this species is a protogynous hermaphrodite accentuates the need for improved sampling.

Growth and reproduction- The RP considered that there could be refinements in the growth and reproductive metrics although more data would be required. It is unlikely that they will make significant changes to the outcome of the model, but should improve the description of both metrics. Further discussion on growth and reproduction can be found in the research recommendations section.

Natural Mortality
Previously, natural mortality (M) was assigned a value of 0.2 in the red grouper assessment model. Direct age data now available show a number of fish aged beyond 25, thus a lower value of M is indicated. Although the AP recommended a value of 0.167 based on a maximum age of 25 and the Hoenig (1983) approach, the RP considered the gradual tail-off of fish beyond age 25 and out to age 29 to be consistent with a value of 0.14 for M. The RP concurs with the use of an age-dependent pattern in M that is scaled to body weight based on the Lorenzen (2000) method. However, the RP finds that the scaling recommended by the AP produced an underestimate of the natural mortality level for older fish because it included the youngest (age 0, 1, 2) groups in the calculation of the average natural mortality. A revised scaling based on age 5-29 is recommended because this is the age range of samples used to derive the average M of 0.14. Revised base models were conducted with this revised scaling.

Spatial data (and movement):
The RP concurs with the assessment of red grouper in the Gulf of Mexico as a single stock principally found along the west-central coast of Florida. Within this area the spatial patterns described in the Data Workshop report (p. 16) were mentioned during the RP workshop: shallow to deep movements of cohorts, movements associated with hurricanes. Similarly ontogenetic movement from north to south was also suggested from the age composition of the northern and southern NMFS long-line survey catches and fishery catch-at-age. In addition to these movements there was a suggestion that there had been a recent range expansion in the northern regions. This was supported by the increased occurrence of red grouper in the northwest FL recreational fishery data and an associated small but increasing CPUE over the last 4-5 years in this NW area. Causes for

the range expansion were uncertain and suggestions included a response to the increasing frequency of hurricanes and the increased abundance due to the 1999 recruitment peak.

Fishery Data

Catches

Retained catch data seem generally reliable for the modeled time period 1986-2005. Catches are recorded in weight for the commercial fishery and numbers for the recreational fishery. Conversion between catch and weight occurs within the model as necessary and does not appear to be a significant source of uncertainty.

Discards

The discard information is one of the most uncertain of the data inputs. Not all discarded fish die, and mortality in the recreational and trap catches is thought to be low. Discard mortality in numbers is currently estimated to be about a third of the total catch split relatively evenly between the commercial longline and the recreational discards. Several changes in the estimation of gear-specific discard and discard mortality rates were recommended by the DW and AP. The RP concurs with these recommended changes, but notes that there are several components of discard mortality that could be improved through improved data collection and analysis. In particular, the longline discard rate is based on information from the handline fishery, the discard rate from the recreational fleet is self-reported, and all estimates of discard mortality rate could be improved. More detailed recommendations are found in the recommendations section.

Age Compositions

The age composition data is important to the assessment and has been made more reliable by using direct, randomly sampled age observations rather than age inferred from length. The RP strongly supports the continued use of direct age estimation in the assessment. In the research recommendations, the RP discusses some possible methods to use some of the historical length data and possible length-stratified sampling for age determination to increase the precision of the estimates for the less common older fish.

Spatial Structure

There appears to have been an increase in recreational fishing activity in the NW area associated with higher catch rates in that area. However, the majority of the total catch occurs in the southern areas, and it is assumed that the majority of the stock resides there. Some north-south differences in growth and consistent differences in age composition between north and south indicate that whatever mixing occurs between north and south it is insufficient to homogenize these patterns. However, there was insufficient information to consider whether the areas could or should be treated separately. The catch data could, if considered necessary in future, be split between North and South stock areas.

Extending Catch Time Series Back

The full catch time series, which goes back to 1880, was not used. The RP believes that the full catch time series has been reasonably derived, but the historical catch data certainly is less reliable. For example, before 1986 the grouper landings are not differentiated among grouper species, but a fixed proportion by gear is applied to estimate red grouper. Most species are either gag or red grouper. The Cuban aggregated data is not necessarily accurate and shows great shifts, which are attributed to political

changes during the period. A model that incorporates such a long time series could be informative because it could test whether the productivity implied by the current assessment could support the exploitation history. Such a model should be designed to acknowledge the greater uncertainty in the early catches.

Indices of Abundance

The review panel considered that the DW and AW had been rigorous and conscientious in developing the available stock abundance indices. In general, the approach used to standardize the indices was adequate and after standardization, the indices chosen indicated a general upward trend since the mid-1990s. The RP accepted the indices used by the AP with a recommendation on potential lack of constancy in the catchability of the fishery catch rate series.

The panel discussed the utility of the NMFS long-line survey for model calibration and concluded that in principle, this series probably has the greatest potential for reflecting trends in the stock. At present however, the time series is short and survey coverage in two of the six years was poor and restricted to the northern part of the survey area. The AW did not include the survey in its base run on the grounds that it was a short time series, highly variable and largely without trend. The RP did not feel that these were good reasons to exclude the index. Because of its potential to reflect stock trends, the panel felt that it should be used excluding the data for the years 2000 and 2002 when coverage was poor. The RP recommended that the nominal indices would be appropriate for the Fishery Independent NMFS Bottom Long-line Survey because it is has, by design, good coverage of the stock's area and there is no obvious benefit to be obtained from the application of a Generalized Linear Model. The nominal indices were not available during the workshop.

The RP identified a number of issues that it considered should be investigated for future assessments. These issues are documented in the research recommendations.

2) Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.

The Gulf of Mexico red grouper stock was assessed using the Age-Structured Assessment Program (ASAP). This program, developed in 1998 by Legault and Restrepo, is adequate and appropriate for this assessment. It was designed to assess stocks with data comparable to the data available for red grouper and to provide management advice in terms that meet the needs of the Gulf of Mexico Fishery Management Council. In particular, ASAP can explicitly deal with the fact that a substantial portion of the total fishery caused mortality is not attributable to the retained catch. The ASAP program has been included in the NMFS Stock Assessment Toolbox as one of the core assessment programs, thus reinforcing the confidence that ASAP is an adequate and appropriate assessment program. The version of ASAP used to conduct the red grouper assessment is fundamentally similar to the version included in the Toolbox, and has appropriate modifications to address the particular needs of this assessment.

Although the RP found that the ASAP model is adequate and appropriate for this assessment, it does have limitations. In particular, it could not be configured to work

with a long time series dating to the earliest years of the fishery (circa 1880), and some of the model inputs require substantial pre-processing such that the estimates of uncertainty in model results are not able to incorporate this additional uncertainty due to the pre-processing steps. The future recommendations section identifies the recent availability of more comprehensive and flexible models that may be applicable for future red grouper assessments.

The RP identified four factors that were adjusted in a revised base model. These factors are: natural mortality, trend in catchability for the fishery catch per effort indices, inclusion of the NMFS bottom long-line survey, and the level of emphasis to place on the age composition estimates for the discarded component of the catch.

Natural mortality – As described in TOR-1, the RP concurs with the DW and AW in using a level of natural mortality that is scaled to body weight and consistent with new evidence of the longevity of red grouper, but recommends a more appropriate scaling of the natural mortality. The RP finds that the level of natural mortality is an influential, but difficult to estimate, parameter as it is in most other assessments. The level being used here is consistent with available information, but there is uncertainty. The RP cannot bracket this uncertainty with a quantitative confidence interval on natural mortality. The sensitivity analyses with respect to natural mortality undertaken during the workshop are intended specifically to demonstrate the degree to which the assessment results are influenced by the level of natural mortality. The sensitivity analyses should not be interpreted as a confidence interval around the best estimate being used in the revised base model.

Fishery catchability – Commercial and recreational fishery CPUE have been included in the red grouper model as plausible indexes of the trend in stock abundance. However, the RP recognizes that it is not possible to standardize the units of fishery effort over time to the same degree that the units of effort in a fishery-independent survey (such as the bottom longline survey and the video survey) are held highly constant. The panel agreed that it would be unrealistic to assume constant fishery catchability over 20 years and requested that an annual 2% increase in catchability be incorporated in the base run to reflect increased fishing power (efficiency) principally due to technology innovations (GPS, GIS, cell phone communication, etc.) that cannot be quantitatively included in the standardization. This means that over a 15-year period, a 35% increase in observed fishery CPUE would be expected from a stock that was level in its abundance. The representatives of the fishing industry attending the meeting agreed that 2% per year was within a likely range. The RP finds that the direct information to calculate the historical drift in catchability does not exist and makes some research recommendations in TOR-9. For sensitivity analyses, the RP recommends model runs based on 0% and 4% per year trend in catchability.

NMFS Bottom Longline survey – Although the bottom longline survey has not yet been conducted for enough years to describe long-term trends in red grouper abundance, the RP finds that this survey has the appropriate characteristics to be a very useful indicator for red grouper: In most years it has covered the principal range of red grouper, it is highly standardized, and it provides size and age

composition data. Although the RP does not expect the bottom longline survey to be influential in the current assessment's results because of its short duration, we recommend including it in the model to reinforce our conclusion that this survey has high merit, should be continued and, be included in future red grouper assessments.

Discard age composition – The RP recommends reducing the influence of the derived discard age composition data in the base model. There are no direct otolith age observations collected from discarded fish and the age composition estimates derived from the length composition data do not contain the recruitment signal apparent in other model data. The RP recommends reducing the influence (e.g. effective sample size) of each discard age composition from the level of 11.6, which would be as or more influential than 12 of the direct otolith age composition observations, to a level of 1, which would be the same as the lowest influence level for the direct age observations. For comparison, the most heavily sampled of the direct age composition samples had an influence level of 200. As expected, with the reduced influence of the discard age composition information, the ASAP model produces a slightly larger range in estimated year-to-year changes in recruitment.

3) Recommend appropriate estimates of stock abundance, biomass, and exploitation.

The time series of estimated stock abundance, biomass and exploitation was calculated from the base model as revised according to the RP recommendations. These estimates are presented in the advisory report.

4) Evaluate the methods used to estimate population benchmarks and management parameters (*e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies*); provide estimated values for management benchmarks, a range of ABC, and declarations of stock status.

The estimates of population benchmarks and management parameters have been calculated using standard, routine procedures. These values are tabulated in the advisory report.

The exact values of these parameters are related to various factors estimated in the assessment, particularly the level of natural mortality and spawner-recruitment steepness. Both of these factors will be subject to revision as subsequent assessments are conducted with more data, so some modification of these management parameters is to be expected in the future.

On the basis of these estimated parameters, the RP finds that the Gulf of Mexico red grouper stock is not experiencing overfishing and it has fully rebuilt from previous low levels of abundance. In fact, its abundance is at approximately the exact level to be expected from a stock fished at 75% of Fmsy. Current fishing mortality rate is very close to 75% of Fmsy, so efforts over the past few years to curtail the pace of the fisheries have resulted in the fishing mortality being at the target level. Continued fishing at 75% of Fmsy would produce an ABC near the status quo level as documented in the advisory

report. This ABC is calculated for landed catch and it takes into account the effect on the stock of associated discard mortality.

5) Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).

The RP finds that the method used to project future stock status is adequate and appropriate. The method is based on calculation of the fishing mortality rate (F) that would produce long-term maximum sustainable yield (MSY), then applying this and other F levels into the future using: the estimated current stock abundance, expected mean and variability of future recruitment levels, expected catch for the 2006 and 2007 fishing years based on management measures currently in place and recent fishery performance. Such an approach is similar to the approach used in other regions and is adequate for providing technical advice for the management of red grouper. Use of the target reference point at 0.75 Fmsy is appropriate as it provides a degree of precaution for the fishery given the uncertainty in the assessment and in the fishery associated with recruitment variability, discard survival and limited fishery independent indices.

Caveats:

The recent status has improved with the large 2000 year class, but no recruitment information is available since 2002 due to the gap between settlement and recruitment to the fishery. Recruitment since 2002 is only an average of past recruitment. The MSY-based benchmarks are solely from the Beverton-Holt stock-recruitment model. The parameters of this stock-recruitment model are not precisely estimated, partly because the assessment model begins after historical fishing had already reduced the stock abundance. In addition, there is an argument that the Ricker curve might be more appropriate where there is significant habitat limitation on recruitment and stock size.

6) Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide measures of uncertainty for estimated parameters. Ensure that the implications of uncertainty in technical conclusions are clearly stated.

Some uncertainty is to be expected. More sophisticated models with extensive sets of appropriate data can reduce uncertainty, but uncertainty cannot be eliminated altogether. The RP finds that the degree of uncertainty in the red grouper stock assessment is not so high as to interfere with the use of these results as the technical basis for management of this stock.

Although we are confident in this conclusion, there are some factors that would cause the quantitative estimate of uncertainty to underestimate the possible range of uncertainty. The ASAP assessment model routinely provides estimates of uncertainty in model parameters and stock factors such as recruitment, abundance and fishing mortality. These estimates of uncertainty are based upon the degree to which the currently configured

model can fit the data. The 95% confidence interval on current stock status is approximately +- 14% of the mean estimate, although this estimate of the confidence interval does not include all potential factors that could contribute to the uncertainty. These estimates of uncertainty have been supplemented with sensitivity analyses for alternative model configurations. The RP finds that the level of natural mortality and the degree of drift in fishery catchability are influential aspects of the model configuration and appropriate sensitivity analyses to alternative levels of these configuration factors have been provided. The RP notes that a plausible +- 10% change in the level of natural mortality causes a comparable change in the current stock status, and a similar sensitivity is found for the drift in catchability.

A more complete quantification of uncertainty is beyond currently available technical methods, but such an ideal quantification would encompass natural mortality, fishery catchability, recent recruitment levels and even the influence of ecosystem factors on the productivity of the stock. The current management plan sets the target level of the fishery at 75% of the best estimate of the fishing mortality limit. Such a buffer is consistent with the degree of uncertainty in this assessment.

7) Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.

The RP recommended modifications to the base model and sensitivity analyses as described in TOR 2. The results of these modifications are documented in an addendum and summarized in the Advisory Report.

8) Evaluate the SEDAR Process. Identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops; identify any additional information or assistance which will improve Review Workshops; suggest improvements or identify aspects requiring clarification.

The RP was pleased by the smooth operation of the SEDAR process. All participants contributed to its success.

The breadth of experience of reviewers selected for this SEDAR workshop improved the review and provided insight in many areas which otherwise would not have been given.

Future SEDAR review workshops should consider having a representative of the data community in attendance. While models and analyses tend to be broadly consistent between stock assessments, data can have peculiarities which can only be elucidated from the inside knowledge of those who collect and/or manage the data. While the DW report contains much of the necessary information, a representative of the DW would be useful to highlight important issues and provide insight on the provenance and accuracy of data.

The RP was surprised that there was no ecosystem/environmental perspective provided during the DW, AW or RW given the increasing requirement globally to address fisheries in an ecosystem context (ecosystem based fishery management). Environmental data could assist in interpretation of recruitment trends, range expansions and changes in catch

rates. Similarly it was also surprising that information on similar species that occur within this region (e.g. Gag grouper) were not used to compare similarities in recruitment or fishing patterns.

Concentrating on one species allowed more in depth review and improved the quality of the results from the SEDAR process. It was recognized that this makes the process more expensive, but it is preferred compared to trying to cover several assessments in the same meeting. To contain costs, it is reasonable to conduct full reviews, like this SEDAR 12, less frequently and triggered by specific criteria so that interim stock assessment updates can be conducted more frequently without repeating the entire review process. Criteria could include significant change to the scientific advice to managers, changes to the overfishing or overfished status of the stock, availability of significant new data or assessment methods, request from the assessment or data workshops to adjudicate on issues for which they could not reach a consensus and objections from stakeholder groups which require arbitration.

9) Review the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment.

The RP was not able to examine and comment on the research recommendations of the DW and AW item by item, but our recommendations broadly mirror those made by the DW and AW. The RP recommendations below are split into a set that is of high priority to address in the next major assessment and a set of other recommendations that are of interest but are not expected to be feasible soon or are not expected to make a substantial change to the assessment result. Finally, the RP provides some additional discussion on these research topics.

HIGH PRIORITY RESEARCH RECOMMENDATIONS

LIFE HISTORY

- Verify and improve the estimate of age-dependent natural mortality.
- Improve the metric of reproductive output. This will involve expanded sampling to get adequate coverage in season, geography, and size/age range and the collection of relevant abiotic factors associated with the samples. It will also involve special consideration of this species' female to male gender change.

FISHERY

- Expand at-sea sampling to improve estimates of discard for each fishery sector
- Conduct special studies to improve estimates of discard mortality for each fishery sector and in association with various fishery and environmental factors

INDICES

- Conduct NMFS longline survey annually with full spatial coverage; consider the feasibility of a cooperative survey with industry to expand cost-effective coverage.

- A pre-recruit survey is needed if future management is to be more responsive to recruitment fluctuations.
- Collect additional data (expanded logbooks, fisher interviews, historical personal logbooks) relevant to the standardization of fishery catchability in order to refine the current recommendation for a 2% per year inflation in fishery catchability.
- Improve the statistical model (GLM – Generalized Linear Model) used to derive an annual index from the fishery catch per effort data. The model should be more explicit with regard the included factors and covariates. Currently some factors affect catchability and some are related to spatial/temporal patterns in fish density. The form of the GLM needs more justification than statistical significant inference. The focus of the model needs to be creating an index that will be proportional to the total stock abundance.

MODEL

- The ASAP model used for this assessment provides an adequate means to interpret most data and produce estimates of stock status with associated estimates of uncertainty. In the time since ASAP was developed (1998), there have been continued advancements in the models available to conduct such analyses. The current generation of integrated analysis models are able to incorporate both age and length data, to extend over long time periods with limited data, to incorporate environmental information where relevant, and to include more factors in estimating the confidence interval around stock status and projections. Transition to such a model is recommended for the next major red grouper assessment.

ADDITIONAL REVIEW PANEL RESEARCH RECOMMENDATION

LIFE HISTORY

- Investigate a two-gender growth model that explicitly addresses maturation and protogynous hermaphroditic gender change;
- Use tagging to further evaluate north-south connectivity;
- Explore temporal and/or density-dependent changes in growth and reproduction, including investigation of possible abiotic effects such as temperature;
- Publish a technical document about the application of Lorenzen method to convert conventional constant M to age-dependent M (avoid problem with the maximum age over which average has been developed).

FISHERY

- Support ongoing work to evaluate and reduce possible bias and precision of recreational catch estimates;
- Evaluate sampling design for fishery length and age composition sampling for optimum cost, precision, analytical flexibility;
- Include more documentation of patterns in the fishery (seasonal, geographic, quota attainments, etc.) in the next assessment report.

INDICES

- Evaluate the mix of surveys (longline, trap, SEAMAP video survey) to achieve best coverage of recruits and pre-recruits across relevant habitats and geographic and depth ranges.

MODEL

- Consider extending the model over different time periods. One sensitivity option would limit the assessment to the period after 1990 when the new 20 inch minimum size came into affect. Prior to 1990, data are different due to the size limit change so consider discarding pre-1990 data and fit the model to this shorter time series. Another option would be to complete the investigation of model performance and inference when the entire time series since 1880 is included. Such a long time series would have uncertainties due to assumptions about fishery characteristics in the early years, but could provide a check on the consistency between estimates of stock productivity and the cumulative removals over the entire time period.

ADDITIONAL DISCUSSION ON RESEARCH RECOMMENDATIONS

The comments below expand upon the recommendations above and provide an expanded exploration of the topics. In places these exploratory comments may appear to contradict recommendations made in the previous section. Such apparent contradictions are a manifestation of the constant scientific inquiry in the SEDAR review process. They are an indication that all findings have some associated uncertainty and room for improvement, but they do not negate the basic finding of a sound assessment.

LIFE HISTORY

The topic of stock definition was not discussed in detail at the review workshop. The Data Working Group suggested that research aimed at identifying recruitment peaks in each of the main fishing regions be explored with the assumption that similarity in peaks would suggest common recruitment patterns and a single spawning stock. The age composition provided through the NMFS Bottom Longline Survey suggested a similar 1999 recruitment peak. Continuation of this survey ensuring adequate north and south coverage is important. The age structure tends to suggest that there could be movement of younger fish from north to south, or a higher total mortality rate (Z) in the north. However, the Mote Tagging Database did not exhibit directed north to south movement. A more comprehensive tagging program may help elucidate the connectivity between north and south regions. There was also concern that there was spatial heterogeneity in the data that was not being captured in the descriptions. There were differences in the length-age data for depth, sector (commercial vs. recreational) and region.

The RP considered alternative methods for estimating natural mortality (M). A promising approach would be to use sampling and experiments in the Dry Tortugas Marine Reserve, where fishing mortality might be considered negligible. If scientific/experimental fishing was allowed, it may be possible to use both catch curve and tagging studies (multi-period

models) to obtain an estimate of M and to determine if the natural mortality followed the form proposed by Lorenzen (1996, 2005).

The RP supports necessary continued work to calibrate and standardize otolith age determinations, as recommended by the DW.

Although the VB growth curve was a reasonable fit to the data there appeared to be a distinctive pattern in the residuals. The younger and older fish were underestimated and the middle aged fish a mixture of both. Because of the energy demands on a species that changes sex, a normal VB curve maybe inappropriate. It appears possible that the growth curve is a mixture of 3 separate events: female growth, transitional growth and male growth. The higher values for the start of the VB curve could be associated with faster female growth (pre-maturity), the flatter middle section of the curve with transitional growth (females use majority of energy for transition) and, the higher values at the end of the growth curve associated with male growth which would be relatively faster as gonad development requires less energy. The current growth curve estimates L_{inf} at 854mm although fish up to 1007mm have been caught. Size frequency tables in DW-03 indicate that fish in the length class 900 were consistently present in the fishery.

Relative fecundity is a product of percent female, percent of females mature and gonad weight. The power function used to describe reproduction (Figure 2, page 28, Section 3 of Stock Assessment Report) is based on the 0-9 year data set as this is associated with the majority of the data. A bias corrected power function was then used to estimate the mean gonad weight for ages 10-20. Although based on small sample sizes the average gonad weight for the ages 11-15 are above the power function suggesting that this function may be underestimating gonad weight for the larger animals. While the majority of the catch is currently below 10 years of age, a greater number of 10+ aged fish are beginning to appear in the catch. With rebuilding of the stock the number of 10+ fish is expected to increase. Any change in the reproductive relationship that increases the reproductive output for larger fish may therefore have a greater impact in the future.

Another possible explanation for the low gonad weights for very large fish is that these fish are in the sex transition phase and have reducing ovaries. As the rate of sex transition is unknown, it is uncertain if a range of gonad weight for an expected age will result from different stages of transition (i.e., if sex transition occurs over 2 seasons there could be 3 different gonad conditions: full female – female with reduced ovary – full male). It is also possible that these fish are periodically skipping spawning periods. Annual reproduction should not include skip spawners in either the percentage mature or in the gonad weight relationship (Figure 14, DW 4), but should be estimated as a separate component. Future analyses should consider the ‘transitional fish’ and how they contribute to spawning biomass. In the dataset provided there were a number of females that had sperm or plugs (indicator of skip spawning) present that mainly contribute to the model variance. Whether these should be included as females in the proportion female is uncertain, and their contribution to annual egg production should be considered in greater detail.

FISHERY

Discards are not directly observed but estimated from various sources. Long-line discards form the majority of the discard mortality. However, because discard rates for the long-line fishery based on observer data were thought to be biased underestimates, these were inferred from reported hand-line discard rates. As the hook sizes are the same, selectivity for hand-line and long-line are thought to be approximately the same, despite long-line being set a little deeper. The recreational fishery tends to target smaller fish, so a high proportion of the catch is below the minimum size. The recreational bag limits do not appear to be a major cause of discarding.

The assumed long-line discard rate based on reported discarding from hand-line logbooks suggests that one fish is discarded per 5lbs landed. It was suggested at the meeting by one of the participating fishermen that this is probably an underestimate by as much as a factor of 2. The lack of direct observations makes the assumed values highly uncertain.

Once released, fish mortality due to fishing probably depends upon the depth caught, ascent time, time on deck, predators present and other stress factors. These effects have been confounded across previous studies making interpretation for estimating the gear-based discard mortality difficult. Most fish are killed through baro-trauma, where the swim bladder's expansion causes physical stress on internal organs. Although venting the swim bladder can relieve the stress, it requires some skill. Increased predation on discarded fish may also contribute to post release mortality. Cetaceans and barracuda were reported as being the major observed predators of discarded fish.

Release mortality among red grouper of less than 20 inches total length is not precisely known. Release mortality in a small sample of 21 red groupers caught by hook and line from a depth of 44 m was 29%. Anecdotal evidence from fishermen suggests significant numbers of released red grouper do not survive after release.

The data workshop panel explored the issue of estimating the mortality based on fishing depth, but was unable to estimate depth for all catches. In any case, it appears that attributing mortality to depth alone would only be partially successful, and a more detailed understanding of the causes of mortality is required.

All gears were assumed to have a discard mortality of 10% except long-line, which was allocated a discard mortality of 45%. Long-line discard mortality is thought to be much higher due to the greater depth fished, and possible stress from being hooked on the line for longer periods. Discard mortality in the longline fishery contributes significantly to the total fishing mortality for this mode of fishing. Based on the available data, accurate estimates are not possible, but general indicators were provided. Long-line probably has the highest discard mortality based on reports from fishermen, and consistent with the deeper sets. Recreational discards probably have the lowest discard mortality due to their treatment on deck and relatively low depth. Trap gears will be discontinued, and in any case only forms a small proportion of the total catch. However, there was some concern that the discard mortality of 10% maybe too low for the recreational sector.

Focus improvements in data collection on discards and discard mortality, perhaps using observer program and directed research on contributions to discard mortality from depth, exposure etc as suggested by the Data Workshop panel. Pre-release mortality would be

recorded by observers and should be estimated by the observer program. Post-release mortality can only be estimated by directed research. Rather than link post-release mortality only to explanatory variables such as catch depth, time on deck and so on, which may prove complex, attempts might be made to link post release mortality to variables collected by observers or through a tagging program. For example, size and subjectively-assessed release condition could be recorded routinely by observers and linked to mortality through a research project.

Discards are caused by the management controls that are implemented in the fishery. Further changes to management controls could require modification of the way that discarded catch is included in the model. Where discarding changes significantly, trends may be produced, which are due to changing errors in the discard estimates rather than real changes in the stock.

Reducing discarding generally will reduce sensitivity to the issue of discard mortality. Management controls which discourage discarding, but achieve similar aims of the minimum size through gear selectivity would be preferred if possible.

The current assessment depends on random age sampling to obtain age frequencies necessary for input to the ASAP model. The available length composition data is not used. The recommendation from the data workshop, supported by this RP, is to develop an ALK or similar approach so that length compositions can be used particularly for the younger animals. Direct use of length frequency data may also be integrated into the stock assessment model in future.

For the years before 1990, very little age composition data is available. For these years, lengths are the only information. Conversion of length to age, with appropriate uncertainty, could improve recruitment estimates for years 1986-1989.

INDICES

The RP strongly supported continuation of the NMFS bottom longline survey. It is well-standardized, covers the relevant geographic range, and provides age and size samples. The fact that the time series is short means that the survey cannot exert substantial influence on the model results. However, the RP strongly endorses development of fishery-independent surveys and recommended inclusion of the longline survey in the current model so that it is available for future model updates.

With regard to the SEAMAP video survey, the coverage is largely restricted to an area straddling the 100m-depth contour, which does not coincide with the main distributional area of the stock of red grouper off the west-central coast of Florida. Hence the panel concluded that while the index may be indicative of the trend in the stock, the relationship may not be linear. Nevertheless, the index was retained for the accepted base run.

Fishery catch rate series were treated as abundance indices by the assessment model when most are strictly indices of relative density as interpreted by the GLM standardizations. The RP considered that there is a need to strengthen the GLM approach, since there appeared to be insufficient thought given to the inclusion of all explanatory

variables and confounding of variables that affect catchability with variables that describe spatial differences in density.

The RP was not able to discuss the possibility that factors such as storms and red tides affect catch rates. If direct evidence of such effects is found, then it may be possible to include these factors in the GLM models.

The introduction of a 20" minimum landing size in 1990 had a big effect on the size composition of the retained catch. While this is adequately accounted for in the development of the stock abundance indices, the potential changes in fishing behavior should be investigated.

The panel also considered that the data from the NMFS long-line survey should be investigated in order to derive catchability estimates for long-line, which could be used to guide an analysis of possible changes in catchability in the commercial long-line fishery. Because detailed information on a per-set basis can be obtained from the survey longline, it offers many more covariates for GLM standardization. Appropriate covariates can be identified for the commercial longline, which specifically deal with changes in catchability rather than other factors such as density.

The panel also discussed the utility of the MRFSS index and agreed that since it is based on the results of interviews, its ability to accurately reflect stock trends may be limited and conceivably may be biased. However it was recognized that the MRFSS index included observations on discards, which other indices did not.

The review panel suggested that an expanded log-book program to obtain information on standardized catch per unit effort should be explored. This could be for a selected sub-sample of enthusiastic participants, if not the entire fleet. The panel noted that some fishers keep detailed personal log-book records which potentially contain valuable historical information on catch and effort. Some fishers may be willing to make such records available especially after they have retired from the industry. The panel suggests that the possibility to obtain such records be investigated.

In order to obtain an estimate for the annual change in catchability, the panel suggested that a survey of fishers be undertaken to obtain an estimate of how their fishing power (efficiency) has increased over time. The result could be used to derive an informed estimate and range for annual increases in catchability.

The RP acknowledged that obtaining catchability estimates to describe how fishing power has impacted on catchability is problematic and there are few examples. The following reference may be considered: Fernandez, J.A., Cross, J.M. and Caputi, N. (1997). The impact of technology on fishing power in the western rock lobster (*Panulirus cygnus*) fishery. Proceedings of the

International Congress on Modelling and Simulation, Hobart, Tasmania, December 1997, vol. 4.

CRITERIA FOR NEW ASSESSMENT and REVIEW

With current model and data streams, it should be possible to update normal data streams (catch, catch age composition, survey and fishery CPUE indices) and re-run the assessment model to extend the time series of abundance, recruitment and mortality

estimates. Such updates could be conducted every 1-3 years, subjected to an expedited review and the results could be used to update annual catch limits and other management measures. In the course of such updates, detection of a recruitment event is simply the process working as expected and not necessarily a need for new review. Criteria for determining whether a benchmark assessment and full review could be:

- There are significant changes to the treatment of the data;
- There are significant changes to the model structure, inputs and assumptions. Such factors include natural mortality, catchability, changes in fish-independent index, major revision of GLMs;
- There is a change in the status of the stock or a significant change in scientific management advice;
- There is some other substantial dispute among stakeholders over the assessment, which can only be resolved through an independent review process.

10) Prepare a Peer Review Consensus Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Prepare an Advisory Report summarizing key assessment results. (Reports to be drafted by the Panel during the review workshop with a final report due two weeks after the workshop ends.)

The required reports were prepared and have been included in appropriate sections of this document.

2.2. Analyses and Evaluations

The RP provided no additional analyses and evaluations beyond those documented in TOR 1 and 2 above.

2.3. Additional Comments

The RP has no comments to add beyond those included in other sections of this document.

2.4. Reviewer Statements

The RP consisted of a chair appointed by NMFS and three independent reviewers appointed by the Center for Independent Experts. The consensus summary reported in this document represents the joint work of all members of the RP. The conclusions, findings and recommendations of the RP are agreed to by its members.